Package ‘hawkes’

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Title Hawkes process simulation and calibration toolkit
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Description The package allows to simulate Hawkes process both in univariate and multivariate settings. It gives functions to compute different moments of the number of jumps of the process on a given interval, such as mean, variance or autocorrelation of process jumps on time intervals separated by a lag.
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Jump autocorrelation

Autocorrelation of Hawkes process jumps on nonoverlapping time intervals with lag.

Description

The function returns the theoretical autocorrelation of the number of jumps of a Hawkes process on nonoverlapping time intervals with lag.

Usage

\texttt{jumpAutocorrelation(\lambda_0, \alpha, \beta, \tau, \text{lag})}

Arguments

- \texttt{\lambda_0} Vector of initial intensity, a scalar in the monovariate case.
- \texttt{\alpha} Matrix of excitation, a scalar in the monovariate case. Excitation values are all positive.
- \texttt{\beta} Vector of betas, a scalar in the monovariate case.
- \texttt{\tau} Time interval length.
- \texttt{\text{lag}} Time lag.

Details

Notice that in the scalar case, one must have \beta > \alpha for the process to be stable, and in the multivariate case, the matrix (\text{diag}(\beta) - \alpha) must have eigen values with strictly positive real parts for the process to be stable.

Value

Returns a matrix containing the autocorrelation of the number of jumps of process components.

References


Jose Da Fonseca and Riadh Zaatour Clustering and Mean Reversion in Hawkes Microstructure Models.
Examples

# One dimensional Hawkes process
lambda0 <- 0.02
alpha <- 0.05
beta <- 0.06
tau <- 60 # one minute
tag <- 0 # adjacent non overlapping intervals
h <- jumpAutocorrelation(lambda0, alpha, beta, tau, tag)

# Multivariate Hawkes process
lambda0 <- c(0.02, 0.02)
alpha <- matrix(c(0.05, 0, 0, 0.05), byrow=TRUE, nrow=2)
beta <- c(0.06, 0.06)
tau <- 60 # one minute
tag <- 0 # adjacent non overlapping intervals
h <- jumpAutocorrelation(lambda0, alpha, beta, tau, tag)

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jumpMean

Mean of Hawkes process jumps.

Description

The function returns the theoretical mean of the number of jumps of a Hawkes process on a time interval of length tau.

Usage

jumpMean(lambda0, alpha, beta, tau)

Arguments

lambda0 Vector of initial intensity, a scalar in the monovariate case.
alpha Matrix of excitation, a scalar in the monovariate case. Excitation values are all positive.
beta Vector of betas, a scalar in the monovariate case.
tau Time interval length.

Details

Notice that in the scalar case, one must have beta>alpha for the process to be stable, and in the multivariate case, the matrix (diag(beta)-alpha) must have eigen values with strictly positive real parts for the process to be stable.

Value

Returns a vector containing the mean number of jumps of every process component.
References


Jose Da Fonseca and Riadh Zaatour Clustering and Mean Reversion in Hawkes Microstructure Models.

Examples

# One dimensional Hawkes process
lambda0 <- 0.02
alpha <- 0.05
beta <- 0.06
tau <- 60 # one minute
h <- jumpMean(lambda0, alpha, beta, tau)

# Multivariate Hawkes process
lambda0 <- c(0.02, 0.02)
alpha <- matrix(c(0.05, 0, 0, 0.05), byrow = TRUE, nrow = 2)
beta <- c(0.06, 0.06)
tau <- 60 # one minute
h <- jumpMean(lambda0, alpha, beta, tau)

jumpVariance

| jumpVariance | Variance of Hawkes process jumps. |

Description

The function returns the theoretical variance matrix of the number of jumps of a Hawkes process on a time interval of length tau.

Usage

jumpVariance(lambda0, alpha, beta, tau)

Arguments

- lambda0: Vector of initial intensity, a scalar in the monovariate case.
- alpha: Matrix of excitation, a scalar in the monovariate case. Excitation values are all positive.
- beta: Vector of betas, a scalar in the monovariate case.
- tau: Time interval length.

Details

Notice that in the scalar case, one must have beta > alpha for the process to be stable, and in the multivariate case, the matrix (diag(beta) - alpha) must have eigen values with strictly positive real parts for the process to be stable.
**Value**

Returns a matrix containing the variance of the number of jumps of every process component.

**References**


Jose Da Fonseca and Riadh Zaatour Clustering and Mean Reversion in Hawkes Microstructure Models.

**Examples**

```r
# One dimensional Hawkes process
lambda0 <- 0.02
alpha <- 0.05
beta <- 0.06
tau <- 60 # one minute
h <- jumpVariance(lambda0, alpha, beta, tau)

# Multivariate Hawkes process
lambda0 <- c(0.02, 0.02)
alpha <- matrix(c(0.05, 0, 0, 0.05), byrow=TRUE, nrow=2)
beta <- c(0.06, 0.06)
tau <- 60 # one minute
h <- jumpVariance(lambda0, alpha, beta, tau)
```

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**likelihoodHawkes**

*Compute the likelihood function of a Hawkes process*

**Description**

Compute the likelihood function of a Hawkes process for the given parameter and given the jump times vector (or list of vectors in the multivariate case), and until a time horizon.

**Usage**

`likelihoodHawkes(lambda0, alpha, beta, history)`

**Arguments**

- `lambda0`: Vector of initial intensity, a scalar in the monovariate case.
- `alpha`: Matrix of excitation, a scalar in the monovariate case. Excitation values are all positive.
- `beta`: Vector of betas, a scalar in the monovariate case.
- `history`: Jump times vector (or list of vectors in the multivariate case).
simulateHawkes

Value

Returns the opposite of the likelihood.

References


Examples

# One dimensional Hawkes process
lambda0<-0.2
alpha<-0.5
beta<-0.7
history<-simulateHawkes(lambda0, alpha, beta, 3600)
l<-likelihoodHawkes(lambda0, alpha, beta, history[[1]])

# Multivariate Hawkes process
lambda0<-c(0.2, 0.2)
alpha<-matrix(c(0.5, 0, 0, 0.5), byrow=TRUE, nrow=2)
beta<-c(0.7, 0.7)
history<-simulateHawkes(lambda0, alpha, beta, 3600)
l<-likelihoodHawkes(lambda0, alpha, beta, history)

simulateHawkes          Hawkes process simulation Function

Description

The function simulates a Hawkes process for the given parameter, and until a time horizon.

Usage

simulateHawkes(lambda0, alpha, beta, horizon)

Arguments

lambda0        Vector of initial intensity, a scalar in the monovariate case.
alpha          Matrix of excitation, a scalar in the monovariate case. Excitation values are all positive.
beta           Vector of betas, a scalar in the monovariate case.
horizon        Time horizon until which the simulation is to be conducted.

Details

Notice that in the scalar case, one must have beta>alpha for the process to be stable, and in the multivariate case, the matrix (diag(beta)-alpha) must have eigen values with strictly positive real parts for the process to be stable.
**simulateHawkes**

**Value**

Returns a vector of jump times in the monovariate case, and a list of such vectors for every component in the multivariate case.

**References**


**Examples**

```r
# One dimensional Hawkes process
lambda0 <- 0.2
alpha <- 0.5
beta <- 0.7
horizon <- 3600 # one hour
h <- simulateHawkes(lambda0, alpha, beta, horizon)

# Multivariate Hawkes process
lambda0 <- c(0.2, 0.2)
alpha <- matrix(c(0.5, 0.0, 0.5), byrow = TRUE, nrow = 2)
beta <- c(0.7, 0.7)
horizon <- 3600 # one hour
h <- simulateHawkes(lambda0, alpha, beta, horizon)
```
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